Alaska’s Geotechnical Asset Management Program - Program Update

- Barry Benko – AKDOT&PF
- Dave Stanley – DA Stanley Consulting
- Paul Thompson – Consultant
- Bob Kimmerling – Pangeo
- Mark Vessely – S&W
- Ad Hoc GAM committee
AKDOT&PF Transportation Network

- Low public road centerline mileage (16,301)...
- Low number of bridges (1,196)...
- Vast areas with limited or no connected road system...
- Air travel reliance– 255 airports managed by the agency.
- Extensive marine transportation network: 25 harbors, 33 terminals, 11 ferry vessels
AKDOT&PF asset management programs

Department of Transportation & Public Facilities
Statewide Design & Engineering Services

CHIEF ENGINEER'S OFFICE

(Chief Engineer)
Assistant Commissioner
Roger Healy, P.E.
PCN 25-0110
R25 JMU
465-4918

Administration
Chief Bridge Engineer
Chief of Standards
Chief Ports & Harbors
Chief of Transportation
Asset Management & Research Development
Environmental Engineer
Materials Engineer

Bridge Design
Design & Construction Standards
Ports & Harbors
Transportation Asset Management & Research Development & Technology Transfer
Statewide Environmental
Statewide Materials

TAM Program
GAM Program
AKDOT&PF GAM PROGRAM

Agency Staff:
• Chief Eng Geologist
• Engineering Intern

Research Projects:
• GAM Plan (PDT)
• GAM Development &Implementation (LT)
• Risk Management Framework (S&W)
• Tongass Highway Corridor GAM (LT)
AKDOT&PF GAM PROGRAM

Targeted Asset Classes:

• Rock Slopes
• Unstable Soil Slopes and Embankments
• Earth Retaining Walls
• Material Sites
AKDOT&PF GAM Progress Report 2015

Current Geotech Asset Inventory Census:

• Roughly 1,600 sites in the USMP database [rock slopes, unstable soil slopes and embankments]
• Approx. 1,200 retaining walls
• Approx. 2,900 material sites
AKDOT&PF GAM R&D in 2015

- Methods for determining geotechnical asset condition states
- Cost models to maintain and improve assets
- Asset deterioration rate estimation
- Methods for quantifying asset life cycle cost and risk
- Draft GAM Plan
Prospects in 2016

• Commitment at the division level to support implementation of GAM Plan

• Applications for STIP line items for geotechnical asset preservation activities

• Agency emphasis on pursuing increased level of transition to GIS-based data systems that will foster GAM data and tool use.

• Uh…a return to $100+/barrel oil, please!
GAM Outline (Condensed)

1. Inventory
2. Condition State Assessment
5. Alternative Actions focused on Condition State Improvement
6. Database Interface
7. Event Tracking
8. Decisions, Decisions, Decisions
GAM Outline (Condensed)

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# Unstable Slopes Management Program

**Summary of Inventory Work Completed Through 2015**

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Inventoried Slopes</th>
<th>Assessed Rock Slopes Number/ft²</th>
<th>Assessed Soil Slopes Number/ln ft</th>
<th>Assessed Retaining Walls Number/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Region</td>
<td>770</td>
<td>290</td>
<td>480</td>
<td>0</td>
</tr>
<tr>
<td>Central Region</td>
<td>363</td>
<td>286</td>
<td>77</td>
<td>94</td>
</tr>
<tr>
<td>Southern Region</td>
<td>503</td>
<td>427</td>
<td>76</td>
<td>116</td>
</tr>
<tr>
<td>Statewide</td>
<td>1,636</td>
<td>1,003</td>
<td>633</td>
<td>210</td>
</tr>
</tbody>
</table>

- 1,636 unstable soil and rock slopes rated and inventoried
- 210 retaining walls inventoried
- For unstable slopes, evaluated 45% of AKDOT road miles (NHS routes)
- For retaining walls, evaluated 4% of AKDOT road miles (select locations)
- Inventoried walls (not field assessed): 1,261
- Material Sites: 2,900 (~10 yr. project)
Location of Inventoried Assets

Summary of Inventory Work Completed Through 2015

- Sites sorted by maintenance region (northern, central, and southern)
- For unstable slopes, inventory is complete for NHS routes (45% of AKDOT road miles)
- For retaining walls, inventory covers select areas (4% of AKDOT road miles to date)
### Condition Assessment (Rock Slopes)

**Summarized in TRB Paper 16-4286**

<table>
<thead>
<tr>
<th>Condition State, Condition Index and Action Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 - Good (80-100)</strong> No action needed</td>
<td>Rock slope produces little to no rockfall and no history of rock reaching the road. Little to no maintenance needs to be performed due to rockfall activity. Mitigation measures, if present, are in new or like new condition.</td>
</tr>
<tr>
<td><strong>2 – Fair (60-79.99)</strong> Review status at 5-year intervals</td>
<td>Rock slope produces occasional rockfall with a rock rarely reaching the road. Some maintenance needs to be performed due to rockfall activity to maintain safety. Mitigation measures, if present, are in generally good condition, with only surficial rust or minor apparent damage.</td>
</tr>
<tr>
<td><strong>3 – Fair (40-59.99)</strong> Inspect at bi-annual intervals. Consider mitigation efforts.</td>
<td>Rock slope produces many rockfalls with a rock occasionally reaching the road. Maintenance is required bi-annually or annually to maintain safety. Mitigation measures, if present, appear to have more significant corrosion or damaged minor elements. Preventative maintenance or replacement of minor mitigation components is warranted.</td>
</tr>
<tr>
<td><strong>4 – Poor (20-39.99)</strong> Inspect annually. Perform major rehab and repair efforts.</td>
<td>Rock slope produces constant rockfall with rocks frequently reaching the road. Maintenance is required annually or more often to maintain ditch. Mitigation measures, if present, are generally ineffective due to significant damage to major components or deep apparent corrosion.</td>
</tr>
<tr>
<td><strong>5 – Poor (0-19.99)</strong> Perform major mitigation or reconstruction efforts</td>
<td>Rock slope produces constant rockfall and nearly all rockfall reaches the road. Virtually no rockfall catchment exists. Maintenance is cleaning rock off the site regularly, possibly daily during poor weather. If present, nearly all mitigation measures are ineffectual either due to deferred maintenance, significant damage, or lack of proper design.</td>
</tr>
</tbody>
</table>
Asset Condition by Region - Northern

Summary of Inventory Work Completed Through 2015

- Majority of rock slope face square footage in region in Fair condition
- Majority of unstable soil slope/embankment footage in Poor condition, with many thaw unstable slopes
- No retaining walls inventoried in Northern Region
Summary of Inventory Work Completed Through 2015

- Majority of rock slope face square footage in region in fair condition
- Majority of unstable soil slope/embankment footage in Good condition (B-slope)
- Majority of retaining walls square footage inventoried on Seward Highway and in Anchorage Metropolitan Area in Good condition
Asset Condition by Region - Southcoast

Summary of Inventory Work Completed Through 2015

- Majority of inventoried rock slope square footage in Fair condition
- Majority of inventoried soil slope/embankment footage in Good condition
- Retaining walls inventoried in Ketchikan, Juneau, and Sitka largely in Good condition
Inventory – Rock Slopes
Inventory – Retaining Walls
Inventory – All Mat. Sites
GAM Outline (Condensed)

1. Inventory and Condition Evaluation
2. Condition State Assessment
5. Alternative Actions focused on Condition State Improvement
6. Database Interface
7. Event Tracking
8. Decisions, Decisions, Decisions
Cost Modeling

• Who has a database of GAM Condition States and long-term costs associated with maintenance and mitigation?
Cost Modeling

• Who has a database of GAM Condition States and long-term costs associated with maintenance and mitigation?
  – NOBODY! Creativity needed!
Cost Modeling

• Who has a database of GAM Condition States and long-term costs associated with maintenance and mitigation?
  – NOBODY! Creativity needed!
• Rock Slopes – Statewide MDT RHRS data from 2005
• Unstable Soil Slopes and Embankments – WSDOT Landslide Database and Cost Estimates
• Retaining Walls – AKDOT Bid Tabs for new construction
Results

Condition State vs. Mitigation Cost per Square Foot of Rock Slope Face

- Mitigation Cost vs Condition State
- Average Cost vs Average Condition State
- Mitigation Cost Trendline
## Results

<table>
<thead>
<tr>
<th>Number of Condition States Improved by Mitigation Activities</th>
<th>Rock Slopes – Average Mitigation Costs per sq. ft. of Rock Slope Face</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Geotechnical Component Cost</td>
</tr>
<tr>
<td>1</td>
<td>$3.56</td>
</tr>
<tr>
<td>2</td>
<td>$7.12</td>
</tr>
<tr>
<td>3</td>
<td>$10.68</td>
</tr>
<tr>
<td>4</td>
<td>$14.24</td>
</tr>
</tbody>
</table>
### Implications

| Number of Condition States Improved by Mitigation Activities | Rock Slopes – Average Mitigation Costs per sq. ft. of Rock Slope Face |  
|-------------------------------------------------------------|----------------------------------------------------------|---|
| 1                                                           | Geotechnical Component Cost: $3.56                        |   |
|                                                             | Incorporating Overhead Costs (105%): $7.30                |   |
| 2                                                           | $7.12                                                     | $14.60 |
| 3                                                           | $10.68                                                    | $21.90 |
| 4                                                           | $14.24                                                    | $29.20 |

- Example: 20,000 sf CS 3 slope improved to CS 1 (like new) = 20,000 x $14.60 = $292k

- Permits Programmatic Cost Estimation and Asset Valuation
  - *Does not replace corridor specific studies or site specific cost estimates.*
GAM Outline (Condensed)

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Deterioration Model

• Who has a database of GAM Condition States and long-term deterioration rates in the absence of maintenance activities?
  – NOBODY!

• Expert Elicitation performed
Expert Elicitation

• You have 100 Condition State 1 slopes. How many years until 50 of them have deteriorated to CS 2?
  – 35, 20, 75, 45, 30, 25 years…Consensus of 38.3 yrs
• Same question for CS 2 deteriorating to CS 3 and so on.
Elicitation Results
# Investment Levels & LCCA

<table>
<thead>
<tr>
<th>Treatment</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
<th>$/sq.ft</th>
<th>$k/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain same state</td>
<td>10.00%</td>
<td>15.00%</td>
<td>20.00%</td>
<td>75.00%</td>
<td>75.00%</td>
<td>0.46</td>
<td>4296.9</td>
</tr>
<tr>
<td>Improve by 1 state</td>
<td>0.00%</td>
<td>2.00%</td>
<td>1.00%</td>
<td>25.00%</td>
<td></td>
<td>3.56</td>
<td>650.4</td>
</tr>
<tr>
<td>Improve by 2 states</td>
<td></td>
<td>8.00%</td>
<td>2.00%</td>
<td></td>
<td></td>
<td>7.12</td>
<td>4660.4</td>
</tr>
<tr>
<td>Improve by 3 states</td>
<td></td>
<td></td>
<td>15.00%</td>
<td></td>
<td></td>
<td>10.68</td>
<td>6108.5</td>
</tr>
<tr>
<td>Improve by 4 states</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.24</td>
<td>0.0</td>
</tr>
<tr>
<td>Total acted upon</td>
<td>10.00%</td>
<td>15.00%</td>
<td>30.00%</td>
<td>93.00%</td>
<td>100.00%</td>
<td></td>
<td>15716.3</td>
</tr>
</tbody>
</table>

Unit cost per state improved: 3.56 $/sq.ft, 105% OH%

-% acted upon per year

[Graph showing investment levels and LCCA over time]
Funding vs performance

• More funding gives better condition (as expected)
• 10-year fiscally-constrained condition targets based on expected funding allocated to slopes
• Computed from current condition, deterioration and cost models

For example, funding of $12.2 M/year is expected to yield 31% Good and 8% Poor
GAM Outline (Condensed)

1. Inventory and Condition Evaluation
2. Condition State Assessment
5. **Alternative Actions focused on Condition State Improvement**
6. Database Interface
7. Event Tracking
8. Decisions, Decisions, Decisions
Alternative Actions

• Rock
  – Maintain (Same CS)
    • Ditch Cleaning - Mitigation Maintenance
  – Minor Improvement (Improve CS)
    • Ditch Improvement (concrete barrier) - Scaling
  – Major Improvement (Improve CS)
    • Bolts – Mesh – Attenuator – Barrier – Shotcrete
  – Realignment / Reconstruction

• Soil
  – Maintain (Same CS)
    • AC Patch – Ditch Cleaning
  – Minor Improvement (Improve CS)
    • Reinforced AC Section – Rock Inlay – Rip Rap – Small Buttress
  – Major Improvement (Improve CS)
    • Full Stabilization – Debris Flow Barriers – Tie Back Anchor
  – Realignment / Reconstruction
Alternative Actions

- **Walls**
  - Maintain (Same CS)
    - Vegetation Removal – Coating Application – Facing Repair
  - Minor Improvement (Improve CS)
    - Repair Failing Elements – Reinforce Displaced Sections
  - Major Improvement (Improve CS)
    - Major Repairs
  - Realignment / Reconstruction

- **District Material Scarcity**
  - Maintain (Same CS)
    - Prevent Sites from Closing - Expand when Reserves Drop
  - Minor Improvement (Improve CS)
    - Open new sites – Expand Existing
  - Major Improvement (Improve CS)
    - Open more until full coverage
Alternative Actions
1. 0.75H:1V STA. 269+25 TO STA. 286+75 RT
GAM Outline (Condensed)

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Interactive Maps

- [http://arcg.is/1J46Omp](http://arcg.is/1J46Omp) – (Unstable Slopes – Interim Interface)
- Mobile Application
GAM Outline (Condensed)

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Data Entry Form

Unstable Slope Event Data Entry

Fill out all the information you have on the unstable slope event below. Parkau-related incorporate individual rockfall and landslide events, regardless of road closure. Costs are typically as contained in the MNS system. For sites entered directly from the MNS system, add only events that can be assigned to a single location of less than one mile in range.

1. Enter Information

   - Event Date
   - Site WKT: [Input Field]

2. Select Location

   - Specify the location for this entry by clicking/tapping the map or by using one of the following options.

3. Complete Form

   - [Select Entry] [View Submission]
GAM Outline (Condensed)

1. Inventory and Condition Evaluation
2. Condition State Assessment
3. Cost Modeling \((TRB\ Paper\ 16-4286)\)
4. Deterioration Modeling & Life Cycle Cost Analysis \((TRB\ Paper\ 16-2764)\)
5. Alternative Actions focused on Condition State Improvement
6. Database Interface
7. Event Tracking
8. Decisions, Decisions, Decisions
Future

- AKDOT has committed to GAM Implementation
- Complete Condition Assessments on AHS & NHS
- Trends of HSIP & STIP Projects
- Assets ID’d for inclusion in current & future programs
  - No more 20 yr pavements on 5 yr pavements (Klondike Highway)
  - Improve assets as part of highway & bridge projects (cuts, fills, walls)
  - Stockpile quality excavation spoils in strategic locations
- Training on GAM Use, Available Data, and Future Ratings